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watt tungsten lamp was the largest available giving the required ratio). This ratio was computed from a consideration of the wave-lengths transmitted by the blue glass used, namely, about 710 and 420 $\mu\mu$, and of the indices of refraction of carbon disulphide for these wave-lengths. This part of the bulb was cut out, forming a sort of shallow bowl into which a quantity of carbon disulphide was poured. I thus had an astigmatic plano-convex lens which gave as an image a minute red-and-blue cross when purple light was passed vertically through it. Later the fragment of the bulb was cemented with shellac on to a flat piece of glass, forming a cell into which the carbon disulphide could be introduced. A diagram was used to screen off all but a small portion of the lens.

In a rudimentary way the appearance can be projected on to a screen by passing light obliquely through a common plano-convex lens.³

W. G. CADY

WESLEYAN UNIVERSITY

THE IOWA ACADEMY OF SCIENCE

THE sessions of the academy were held in Carnegie Science Hall, Coe College, Cedar Rapids, April 28 and 29.

The public address by Dr. Edward L. Nichols, of Cornell University, on "The Ends of the Spectrum—the Infra-red and the Ultra-violet," was given on Friday at 8:00 P.M.

Sessions of the academy for the reading of papers were open to the public.

Nitrogen in Rain and Snow: NICHOLAS KNIGHT.

Seventeen samples of rain and snow were collected on the college campus at Mt. Vernon, Iowa, during nine months of the year 1909–1910. The nitrogen in the free and albuminoid ammonia and in the nitrates and nitrites was determined. Comparisons were made of the relative amounts of nitrogen precipitated with the rain and snow. According to the experiments, each acre would receive in the nine months between thirteen and fourteen pounds of nitrogen from the rains and snows.

Perchloric Acid in Electro-chemical Analysis: W. S. HENDRIXSON.

³I am indebted to Professor Raymond Dodge for this suggestion.

Asteroid, 1909, JA: SETH NICHOLSON and ALMA STOTS.

Vaccination against Typhoid Fever: HENRY ALBERT.

The writer briefly reviewed the experimental work on immunization with cultures of typhoid bacilli, then gave the technique and preparation of vaccine as generally employed at present for the preventive vaccination against typhoid fever. The reaction was divided into a local one which disappears in the course of a few days and a general one which he divided into leucocytic, phagocytic, agglutinitic and bacteriolytic. There is an increase in the number of leucocytes, the power of phagocytosis, and of the agglutinins and bacteriolyticins in the blood serum. The presence of immune bodies may be demonstrated as long as one year after vaccination and is of both a higher degree and of longer duration than usually occurs following an attack of typhoid fever. Reasoning from analogy from the protection afforded by one attack of the disease, he believes that the immunity conferred by vaccination exerts more or less protective influence throughout the life of an individual. He would extend anti-typhoid vaccination to all liable to exposure to infection with typhoid fever.

Flowers of Story County: J. M. LINDLEY.

The Succession of Floras on the Sand Dunes of Iowa: B. SHIMEK.

A discussion of the changes of the earliest flora of these dunes, consisting largely of leguminose plants, to the typical prairie flora of the older areas.

The Nebraskan Drift: B. SHIMEK.

A discussion of its distribution and correlation, including the results of recent investigations. The conclusion is reached that this drift can not be correlated with the Jerseyan and Albertan, and that the name "Kansan" should not be transferred to it.

Notes on Fungus Diseases: L. H. PAMMEL.

Gives a record of a very destructive *Exoascus* upon the hard maple in the Rocky Mountains, also an account of the destructive *Exoascus* on the oak, the destructive *Fomes iginarius* on the quaking aspen in some parts of the Wasatch Mountains in Utah, as well as the destructive work of *Pleurotus* upon the box elder and other deciduous trees in Iowa.

An Abnormal Carpel in Stenospermaticum: J. E. GOW.

Notes in Regard to Efficiencies of Luminous Flames: G. W. STEWART.

An investigation of the efficiency of luminous flames would be of interest. Results obtained incidentally were studied, showing that a cylindrical acetylene flame is not so efficient as a flat acetylene flame when judged by the proportion of its radiant energy that is visible. The amount of visible radiant energy that a given quantity is able to furnish should also be considered. Experiments with a flat kerosene flame show a height of flame at which the candle-power-hours-per-gram is a maximum. The problem of obtaining the most efficient flame, in the broadest sense, is complex. It is advisable to get the temperature of the incandescent particles as high as possible, and also to get as many of them per gram of the illuminant as possible. Both of these factors depend upon the shape of the flame.

On the Rate of Recovery of the Elastic Properties of a Certain Wire: L. P. SIEG.

The Measurement of Musical Capacity: C. E. SEASHORE.

The speaker outlined a series of measurements and statistics for a quantitative determination of musical capacity. The principal measurements are on pitch discrimination, perception of consonance and dissonance, tonal memory, tonal imagery, discrimination for intensity of sound, the appreciation of rhythm, rhythmic action and voluntary control of pitch of voice. These exact measurements were supplemented by returns to an elaborate questionnaire on musical education and appreciation and a personal interview after the statistics had been collected.

Illuminating Engineering—A New Profession: ARTHUR H. FORD.

Some Remarks on the Solubility of Certain Salts in Water: LEROY D. WELD.

*Notes on the Pollination and Variation of Red Clover (*Trifolium pratense*):* L. H. PAMMEL and CHARLOTTE M. KING.

Giving notes on the more important insects that pollinate the red clover in the state of Iowa and their relation to fertility; compares the amount of seeds produced per head and the number of flowers, showing an extreme variation.

The Ecology of a Prairie Formation with Adjacent Swamp and Woodland in Story County, Iowa: ADA HAYDEN.

Gives a physiographic account of the region with a physical analysis of the soil and the tem-

perature records for an entire growing season and a list of plants found on each formation and the repopulation of tillable soil which is reverting to prairie.

Some Notes on Iowa Fungi: T. H. MACBRIDE.

*The Flowers of *Myriophyllum spicatum*:* N. D. KNUPP.

Glaciated Rock Surfaces near Linn and at Quarry: W. H. NORTON.

Some Features of the Bering River Coal Field, Alaska: GEORGE F. KAY.

Problems on the Border Lines between Geology and the other Sciences: GEORGE F. KAY.

In this paper attention is called to the need of cooperative work among investigators in the different fields of science. Reference is made to several bulletins and papers which have already been published by the chemists of the United States Geological Survey, by the physicists of the geophysical laboratory, and by other scientists, throwing light on many problems in geology which heretofore were obscure. The necessity for further work upon border problems, already under investigation, and upon many other problems which need solution, is emphasized.

Graphics of Ore Origin: CHARLES R. KEYES.

In calling attention to some of the newest aspects of ore genesis charts were prepared showing (1) the old conceptions of the origin of ore deposits, (2) the later ideas of secondary sulphide enrichment and (3) the latest views concerning the genesis of ore deposits generally. The last mentioned is presented as a rational scheme for a genetic classification of ore deposits.

Depositional Phases of Eolation under the Stimulus of Aridity: CHARLES R. KEYES.

It is now a question whether wind-scour under the stimulus of a typically arid climate is not actually the most potent and persistent of all erosive agencies. Under favorable conditions its general efficiency must greatly exceed that of stream-action in normally moist lands. At any rate, erosionally, its world's work is probably surpassed neither by that of hydrasion nor by that of glaciation.

Volcanic Phenomena of Coon Butte Region, Arizona: CHARLES R. KEYES.

Contrary to the recently expressed views regarding the origin of this remarkable crater, the most critical evidences seem to indicate that this feature of the local landscape is only one of the many manifestations of the explosive type of vulcanism so prevalent throughout the region.

Some Characteristics of Light-negative Selenium: MISS LILAH B. CRUM.

The Use of a Ballistic Galvanometer and a Pendulum for Measuring rapidly Fluctuating Resistances: WM. H. CLARK.

Many methods for measuring constant resistances are employed. The method here described is one that we have used in the physical laboratory at the State University of Iowa to measure a fluctuating resistance. The apparatus consists of a pendulum, a Wheatstone bridge mesh including a battery of small E.M.F., and a galvanometer. The unknown resistance in the fourth arm of the bridge in this particular case happened to be a selenium cell. The pendulum was about thirty inches in length and swung through an arc of twenty-eight inches. The arc over which it swung was graduated with respect to time, the smallest division being .00125 sec. The period of vibration was .6 sec. Four keys adjusted to open and close two electrical circuits were placed on the arc over which the pendulum swung. The operation of the first two keys illuminated the selenium cell, the second two keys operated the galvanometer circuit. The length of time that either circuit was closed was determined by the distance between the two keys which opened and closed that circuit. Keys k_1 and k_2 which operated the lighting circuit were placed a given distance apart corresponding to the desired length of exposure of the cell to light. Then keys k_3 and k_4 were placed apart a constant distance equal to .05 sec. If the change of resistance is called Δx and the length of exposure to light is called Δt , then $\Delta x = cd/\Delta t$ where d is the deflection and c is the galvanometer constant. This equation is used for small resistances. When Δx becomes comparable to x another device is employed. Since Δx is a function of the deflection we replace the unknown fluctuating resistance by a known variable resistance and, keeping the ratio arms of the bridge the same, vary the resistance to secure deflections covering the same range of scale. A curve between change of resistance and deflection is plotted. Then for any deflection caused by the fluctuation of the unknown resistance we can at once read from this curve the corresponding change of resistance. The method is probably as accurate and as easy to manipulate as any method that has been devised for measuring rapidly fluctuating resistances.

The Nature of Light-action in Selenium: F. C. BROWN.

The Doppler Effect in Electrodeless Discharge: FRANK F. ALMY.

Some Laboratory Apparatus in Elementary Physical Measurements: FRANK F. ALMY.

The Action of Epinephrin upon the Muscle Tissue of the Vein: JOHN MCCLINTOCK.

A Method for Studying Embryos as Related to Medical Work: H. J. PRENTISS.

The Peripheral Distribution of Cranial Nerves in Necturus maculatus: H. W. NORRIS and MARGARET BUCKLEY.

The Zoological Rank of Necturus as Indicated by the Origin and Distribution of its Cranial Nerves: H. W. NORRIS.

Notes on Methods for the Study of Amphibian Eggs and Larvæ: ALBERT KUNTZ.

The Development of Lymph Channels in Turtles by the Fusion of Mesenchymal Spaces: FRANK A. STROMSTEN.

1. The theory that the lymphatic system is budded off from the venous system is a direct product of a special method of investigation, *i. e.*, the injection method.

2. The injection method alone is entirely unreliable, because: (a) Only that portion of the lymphatic system which is in direct connection with the point of injection (lymph sacs) is shown, the unconnected spaces are not indicated. (b) Extravasations and venous injections vitiate the results.

3. Serial sections, both injected and uninjected, of turtle embryos of different ages show the successive stages of the development of lymphatics from the spongy mesenchyme surrounding the aorta and larger arteries, through the formation of independent spaces which constantly enlarge and finally fuse to form continuous channels.

4. The endothelium of the lymphatics arises entirely independent of the venous endothelium from the original mesenchymal cells.

Some Notes on Iowa Reptiles: M. P. SOMES.

Building a Museum: T. VAN HYNING.

An outline plan of building an Iowa state museum; showing the approximate amount of museum material in the state required for a museum, together with showing the number of cases required, case space, floor space, etc., for a completed museum representative of the state. A co-operative plan of school museums, whereby the schools of the state may cooperate with the state museum in supplying a museum for all of the schools is proposed.

Notes on the Black-Crowned Heron: B. H. BAILEY.
The College Museum: B. H. BAILEY.

(Abstracts furnished by the authors.)

Eighty-eight new names were added to the roll of membership. The meeting of 1912 will be held at the State Historical Building in Des Moines, and will be a meeting celebrating the twenty-fifth anniversary of the organization of the academy.

Officers elected for the ensuing year are:

President—Louis Begeman, Cedar Falls.

First Vice-president—A. A. Bennett, Ames.

Second Vice-president—C. N. Kinney, Des Moines.

Secretary—L. S. Ross, Des Moines.

Treasurer—G. F. Kay, Iowa City.

Members of the Executive Committee—H. S. Conard, Crinnell; B. H. Bailey, Cedar Rapids; H. M. Kelley, Mt. Vernon.

L. S. ROSS,
Secretary

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 696th meeting was held on May 20, 1911, Vice-president Fischer in the chair. Three papers were read.

Experiments with Different Types of Voltmeters:

Mr. G. W. VINAL, of the Bureau of Standards.

According to Faraday's law for electrolytes the deposits of silver in different types of voltmeters should be equal when the same number of coulombs of electricity has passed through each, provided, however, that there are no secondary reactions taking place. Differences in weight and appearance have been observed, particularly between the porous cup and filter paper forms. We have endeavored to find an explanation of these effects and to push the accuracy of our measurements beyond the limits hitherto attained. A constant temperature balance room has obviated the difficulties usually encountered in weighing the platinum bowls. The current has been measured by balancing the potential drop across a standard resistance against the voltage of a Weston cell and also by the potentiometer method. The purity of the electrolyte is of great importance and the tests will be discussed elsewhere.

The Kohlrausch, or no septum form as we have used it, consists of a glass dish under the anode and a ring of glass in the surface of the liquid to prevent the slime formed during electrolysis from reaching the cathode.

The siphon voltmeter is unsatisfactory even when short siphons of large diameters are used, owing to the heating and large volume of electro-

lyte which may yield erroneous results if the electrolyte is not quite pure.

The filter paper form devised by Lord Rayleigh employs a sheet of filter paper to separate the anode and cathode. We have found the deposits in it abnormally heavy and striated in appearance, which effects are due to the filter paper not being chemically inert. Striated deposits are always heavy. We have studied the cause for striations and find two conditions to be necessary and sufficient for their production, viz., (1) the presence of reducing impurities in the electrolyte, (2) the motion of the liquid over the face of the cathode. When both of these conditions are fulfilled we may suppose any given initial distribution of points of silver which will grow in the direction of the liquid currents (usually vertical) since the crystalline structure is destroyed by colloidal deposits. In this way a crystal grows into the one above it and eventually a striation is formed. The initial spacing of the crystals and consequently the spacing of the striations is dependent on the current density.

T. W. Richards has advocated the use of a porous cup instead of filter paper to more perfectly separate the anode and cathode liquids. He gave as a reason for this substitution that a heavy complex ion could pass through the filter paper and increase the weight of deposit, but we have found that by using two or three thicknesses of filter paper the effect instead of being diminished is materially increased. The evidence of our work does not support the complex ion theory.

We have used two sizes of porous cup voltmeters and find that with electrolytes, a trifle impure, that the larger will give the heavier deposit. This phenomenon we have called the "volume effect." It is a severe test of the purity of the electrolyte. With pure electrolytes the deposits in this form are always crystalline and free from striations. The efficiency of the porous cup as a separator of the anode and cathode liquids is shown by the fact that an impure solution may be placed inside the porous cup without affecting the deposit outside or if the deposit from a contaminated solution be compared with the deposit from the same solution after filtering through a porous cup it will be noted that the striations have disappeared from the deposit.

The small porous cup voltmeter possesses many advantages over the other forms. We find from a long series of determinations two identical voltmeters of this type will agree to within one part in 100,000.